
Future ASKAP Studies of the Local Volume

Lister Staveley-Smith¹

School of Physics, University of Western Australia, Crawley, WA 6009, Australia
 Lister.Staveley-Smith@uwa.edu.au

Summary. The Australian SKA Pathfinder (ASKAP) will be a powerful instrument for performing large-scale surveys of galaxies. Its frequency range and large field of view makes it especially useful for an all-sky survey of Local Volume galaxies, and will probably increase the number of known galaxies closer than 10 Mpc by a factor of two and increase, by at least an order of magnitude, the number detected in HI. Implications for our knowledge of the HI mass function for the very faintest galaxies and for the structure and dynamics of the Local Volume are discussed.

1 Introduction

The Local Volume is a key region for the study of the properties of galaxies, including: (1) their internal structure and dynamics; (2) their spatial distribution and dynamics in an environment which lies in the outskirts of a supercluster; and (3) their complete evolutionary history, by virtue of our ability to resolve individual stars. The Local Volume is particularly useful for studying the faintest galaxies and is well-served by having a wealth of accurate redshift-independent TRGB distances through recent surveys by the HST [4].

As shown elsewhere in these proceedings, detailed studies of Local Volume galaxies in the 21cm line of neutral hydrogen have been particularly fruitful. These have recently been rejuvenated by surveys at other wavebands including those of *Spitzer* and *GALEX*. Due to the sensitivity and resolution, such surveys have often been drawn towards the luminous galaxy population. However, the Local Volume also offers a unique opportunity to study the faintest galaxies observable and many studies (e.g. *SINGG*, *LVHIS*, *THINGS*) have also been careful to select their samples across a range of intrinsic luminosity.

The Square Kilometre Array (SKA) will be a radio telescope of unprecedented power to observe galaxies in the radio continuum and in the 21cm line. Its sensitivity will easily surpass existing telescopes and allow Local Volume galaxies to be studied at the highest spatial resolution. However, it's not due to come on-line for at least a decade. Nevertheless, the next generation of so-called 'SKA pathfinders' are around the corner. Their purpose is to test SKA technologies, yet provide sufficient sensitivity to obtain useful science and provide a valuable source of survey material

Table 1. The planned specifications of ASKAP, as listed in the expansion option of [1].

Specification	Value	Units
Frequency range	700–1800	MHz
Number of antennas	45	
Antenna diameter	12	m
Total area	5089	m ²
System Temperature T_{sys}	35	K
Field of view	30	deg ²
Maximum baseline	0.4 – 8	km
Instantaneous bandwidth	300	MHz

for the SKA itself. Examples of proposed pathfinders are the Allen Telescope Array (ATA) and the Apertif upgrade to WSRT in the northern hemisphere and MeerKAT and the Australian SKA Pathfinder (ASKAP) in the southern hemisphere. In this brief paper, I will look at the implications for our knowledge of the Local Volume of proposed ASKAP surveys.

2 The Australian SKA Pathfinder (ASKAP)

ASKAP (formerly xNTD/MIRANdA) is a so-called ‘1% SKA pathfinder’ although, in reality, it will likely have a collecting area A , of only 0.5% of a square kilometre [1]. However, due to its enormous field-of-view Ω , its speed ($\propto \Omega A^2 T_{sys}^{-2}$) will greatly exceed that of the existing 64 to 300-m class of single-dish radio telescopes and even the large synthesis arrays such as ATCA, GMRT, WSRT, and the VLA. The properties of ASKAP as listed in [1] are summarized in Table 1.

ASKAP is due to be located at Boolardy Station in Western Australia in an extremely radio-quiet environment. It will therefore be able to combine an uncluttered view of the redshifted 21-cm Universe with powerful widefield technology, to produce fast, deep surveys which, apart from the enormous data volumes, will be relatively straightforward to deal with in data reduction pipelines.

3 A Local Volume Survey

A natural survey to contemplate with ASKAP, and one discussed in [1] is an all-sky 21cm survey. Given the specifications listed in Table 1, and given a year of survey time, a survey covering 2π sr will reach an rms sensitivity of ~ 0.26 mJy beam⁻¹ in a resolution element of 100 kHz (corresponding to 21 km s⁻¹)¹. Such a survey will not only be able to detect high-mass galaxies out to slightly beyond $z = 0.2$, but will also detect significant numbers of low-mass galaxies in the Local Volume.

¹ The actual frequency resolution of ASKAP will be better (~ 20 kHz), but 100 kHz is appropriate for galaxy *detection*.

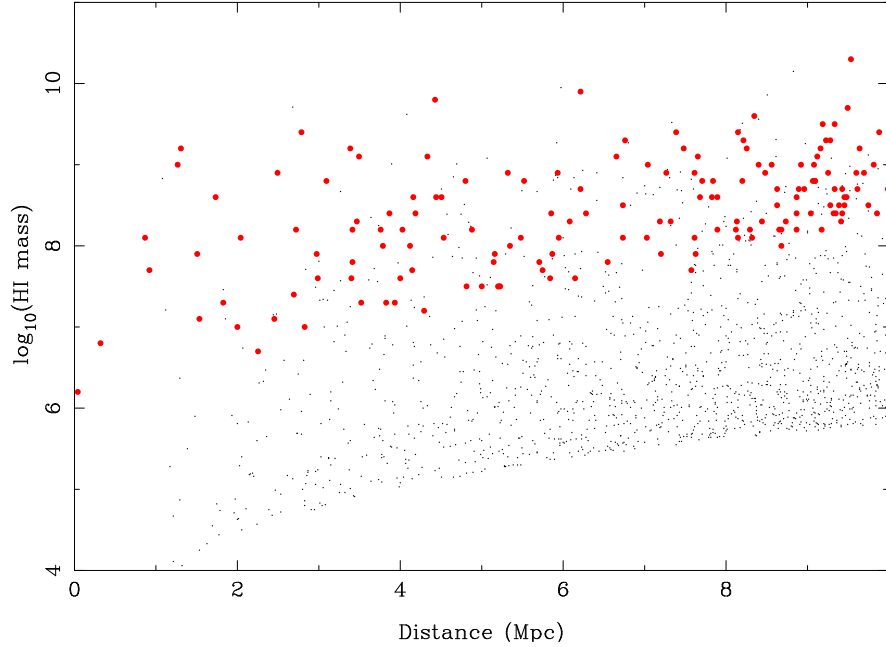


Fig. 1. The HI masses of 1280 putative Local Volume galaxies detected in a simulated 1-yr ASKAP survey covering 2π sr are shown as small dots. Known galaxies, detected in the HIPASS survey [3] are shown as solid circles. This simulation assumes a compact ASKAP configuration, thus represents the maximum number of detections expected. Local Group galaxies within 1 Mpc are not simulated.

Figure 1 shows a detailed simulation of the HI masses of galaxies expected to be detected at distances within 10 Mpc by an all-sky ASKAP survey. The simulation assumes the HIPASS HI mass function [5], a HIPASS mass-velocity width relationship, and a compact ASKAP configuration. At the edge of the Local Group (~ 1 Mpc), a few galaxies of HI masses below $10^5 M_\odot$ are expected and, at all points within the Local Volume, galaxies down to $10^6 M_\odot$ are expected to be detected.

The numbers of galaxies detectable in such an ASKAP survey is enormous – around 2×10^6 out to the survey redshift limit. Within 10 Mpc, around 1280 are predicted, or 2560 over the whole sky if an equivalent northern survey was feasible. This is over four times greater than the number of galaxies (~ 550) presently known to reside in the Local Volume [2], and indicates the impact a future ASKAP survey is likely to make on our knowledge of the region. However, this prediction is heavily dependent on extrapolating the HIPASS mass function by two orders of magnitude down the mass function! Any deviation from this has significant implications for the prediction. This is demonstrated in Figure 2 which is a mass function recovered from the above simulation. Above $10^7 M_\odot$ it reproduces, as it should, the HIPASS mass function. Below that, the recovered mass function has a slope of -1.35 ± 0.01 , very close to the simulated slope of -1.37 . A steeper faint-end slope (a natural prediction for CDM halos) will result in much greater numbers of low-mass objects.

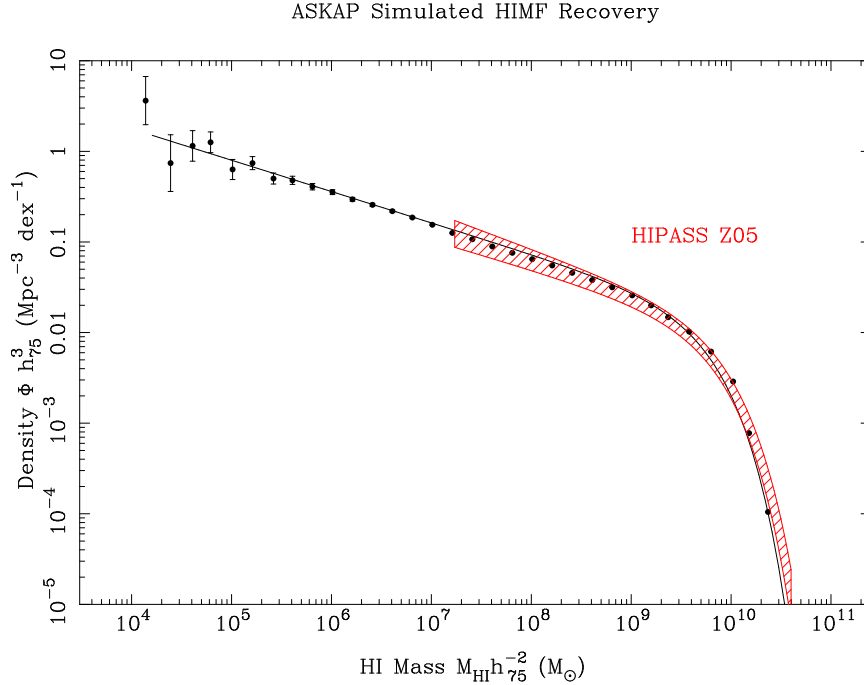


Fig. 2. An HI mass function derived from a simulated 1-yr ASKAP survey covering 2π sr, again assuming a compact ASKAP configuration. For comparison, the known HI mass function from HIPASS [5] is plotted in the hatched area.

4 Discussion

The high number of galaxies that, in all likelihood, remain to be discovered in the Local Volume will allow a remarkably dense sampling of the extragalactic environment of the Local Group. This will allow an accurate mapping of the large-scale filamentary features joining the Local Group with Sculptor and other groups. Combined with the redshift-independent distances that are possible for such nearby objects, it will also allow a study of the Hubble flow, infall towards filaments, and tidal stretching owing to nearby overdense regions such as the Local Supercluster and underdense regions such as the Local Void.

References

1. Johnston, S. et al. 2007, PASA, 24, 174
2. Karachentsev, I. 2007, these proceedings
3. Koribalski, B.S. et al. 2004, AJ, 128, 16–46
4. Rizzi, L., Tully, R.B., Makarov, D., Makarova, L., Dolphin, A.E., Sakai, S., Shaya, E.J. 2007, ApJ, 661, 815–829
5. Zwaan, M.A. et al. 2005, MNRAS, 359, L30–L34